JPRS 76578

8 October 1980

USSR Report

SPACE

No. 7

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MANNED MISSION HIGHLIGHTS

THE KRT-10 SPACE-BORNE RADIO TELESCOPE ON THE SALYUT-6

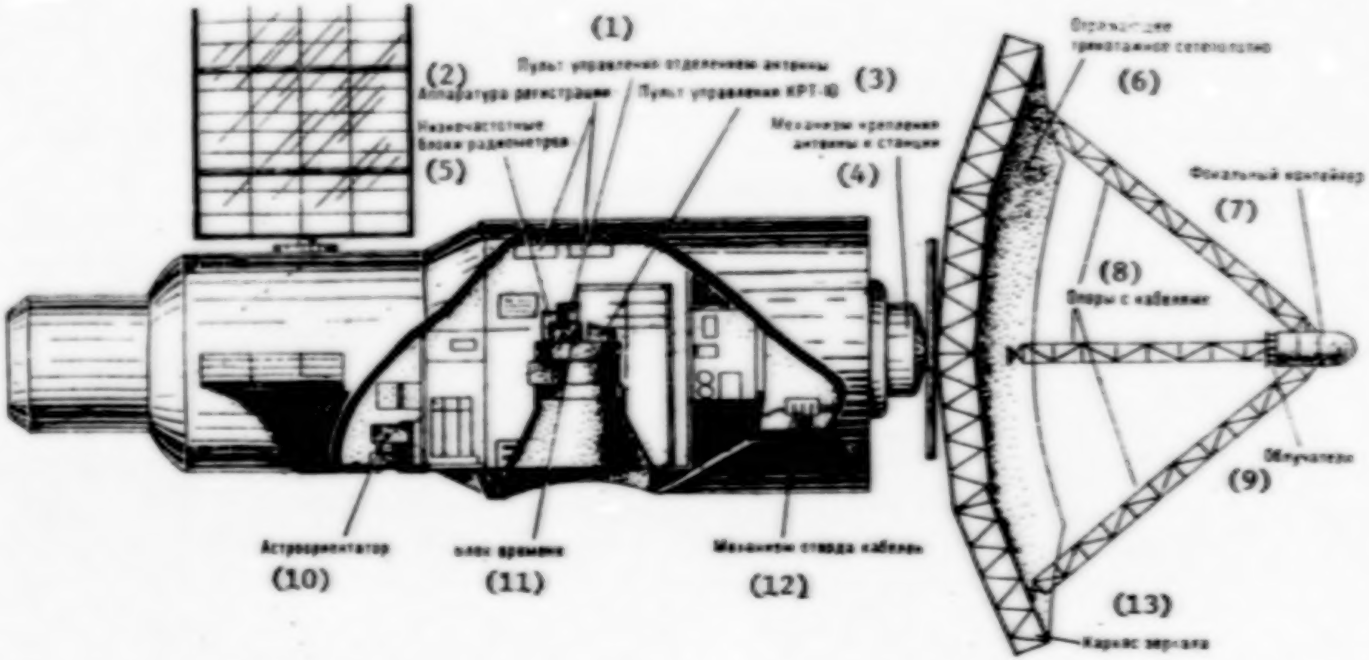
Moscow ZEMLYA I VSELENNAYA in Russian No 4,Jul-Aug 80 pp 2-9

[Article by corresponding members of the USSR Academy of Sciences N.S. Kardashev and A.I. Savin, and Professors M.B. Zakson, A.G. Sokolov and K.P. Feoktistov: "The First Radio Telescope in Space"]

> [Text] The design in the USSR of the first space radio telescope in the world, the KRT-10, its launch into orbit, its deployment and its placement in operation on the "Salyut-6" station, as well as the successful and self-sacrificing work of the cosmonauts V.A. Lyakhov and V.V. Ryumin have opened up a new and important page in the history of space research.

Radio Telescopes in Space for Radio Astronomy

A characteristic feature of radio astronomy is the capability of studying objects, from which an insignificant amount of energy gets through to the earth. This is due on one hand to the low intensity of the background radiation in the radio band, and on the other, the low energy of radio quanta. For this reason, the best ratio of the received useful signal power to the noise power is realized in the radio band for a specified radiation power. This makes it possible to detect and study even those objects, the temperature of which is so low that their radiation falls only in the radio band (for example, clouds of interstellar gas). It is specifically the radio band that one can reliably observe the most remote objects in the universe (for example, quasars with a large red shift and the residual three-degree radiation). Only in the radio band under natural conditions are mechanisms in force which lead to exceptionally efficient radiation. They are similar to the radiation of radio station antennas or laser radiation, but of course, in the radio band. The antenna mechanism is characteristic of the radio emission of the electron-positron plasma of the atmosphere of pulsars, while laser emission is characteristic of some interstellar diffuse nebulas. The process of anomalous radio emission (for example, in the water vapor line at a wavelength of



Schematic showing the equipment layout of the KRT-10 in the "Salyut-6" station.

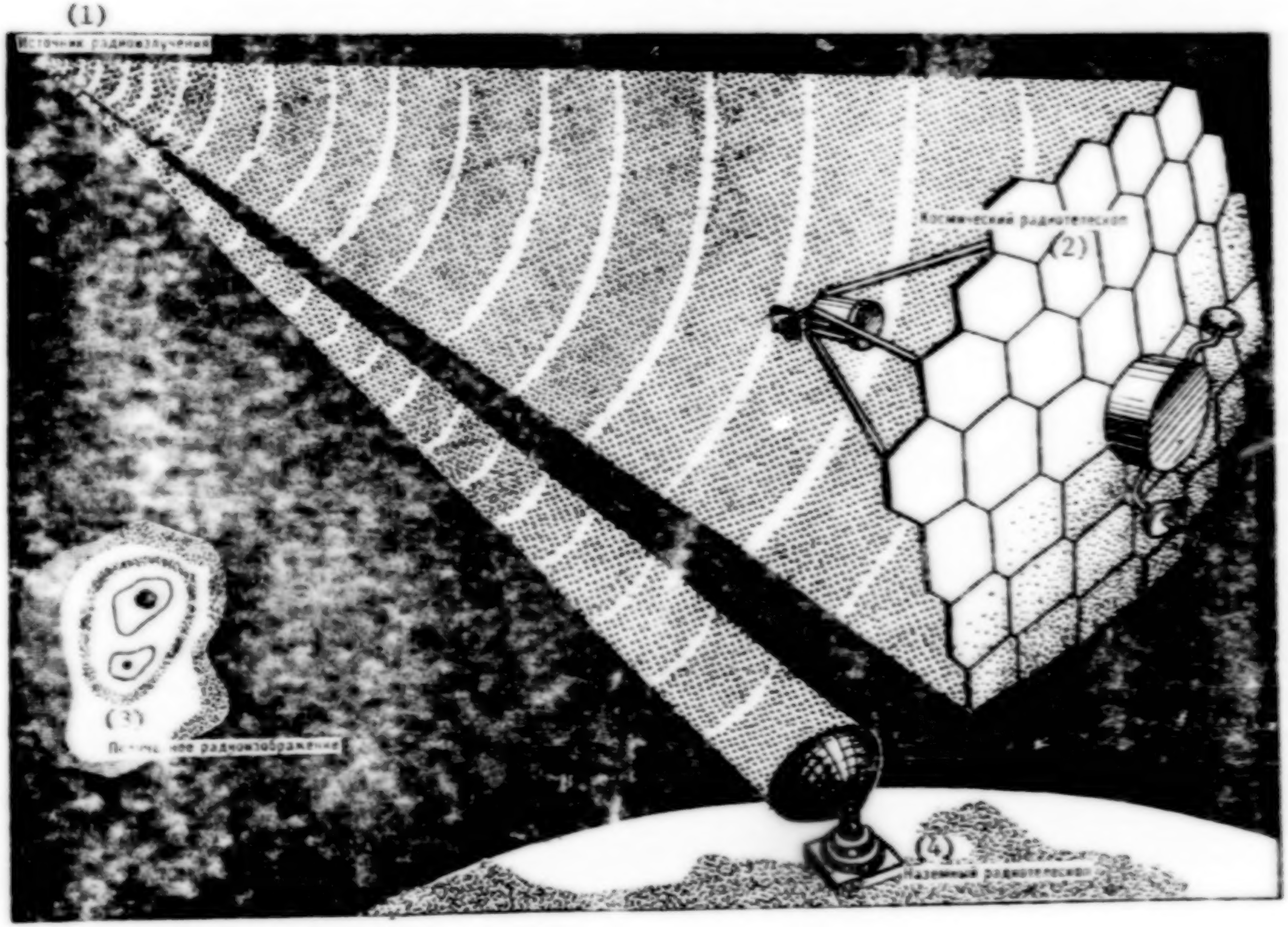
Key:
1. Control panel for the antenna compartment;
2. Recording equipment;
3. KRT-10 control console;
4. Mechanism securing the antenna to the station;
5. Low frequency radiometer units;
6. Reflective netting curtain;
7. Focal container;
8. Supports with the cables;
9. Feed horns;
10. Star tracker;
11. Time block;
12. Cable entrance mechanism;
13. Reflector framework.

1.35 cm or in the hydroxyl line at a wavelength of 18 cm) usually corresponds to the active phase of star formation.

The major parameters of a radio telescope are the sensitivity and the angular resolution (ZEMLIYA I VSELENNAYA, 1976, Nc 4, pp 2-12 - ed.). The greatest angular resolution in radio astronomy is obtained when several antennas which are spaced apart form a common antenna system: a radio interferometer. The angular resolution of a radio interferrometer is determined by the ratio of the wavelength to which the receivers are tuned to the distance between the extreme end antennas (the interferometer baseline). Today, the areas of the largest ground based antennas are measured in thousands of square meters, while the baselines of radio interferometers are close to the diameter of the earth (ZEMLIYA I VSELENNNAYA, 1978, No 1, pp 4-11 - ed.). The maximum sensitivity of radio telescopes is about 10^{-30} watt/m^2 · Hz, while the angular resolution approaches 0.0001".

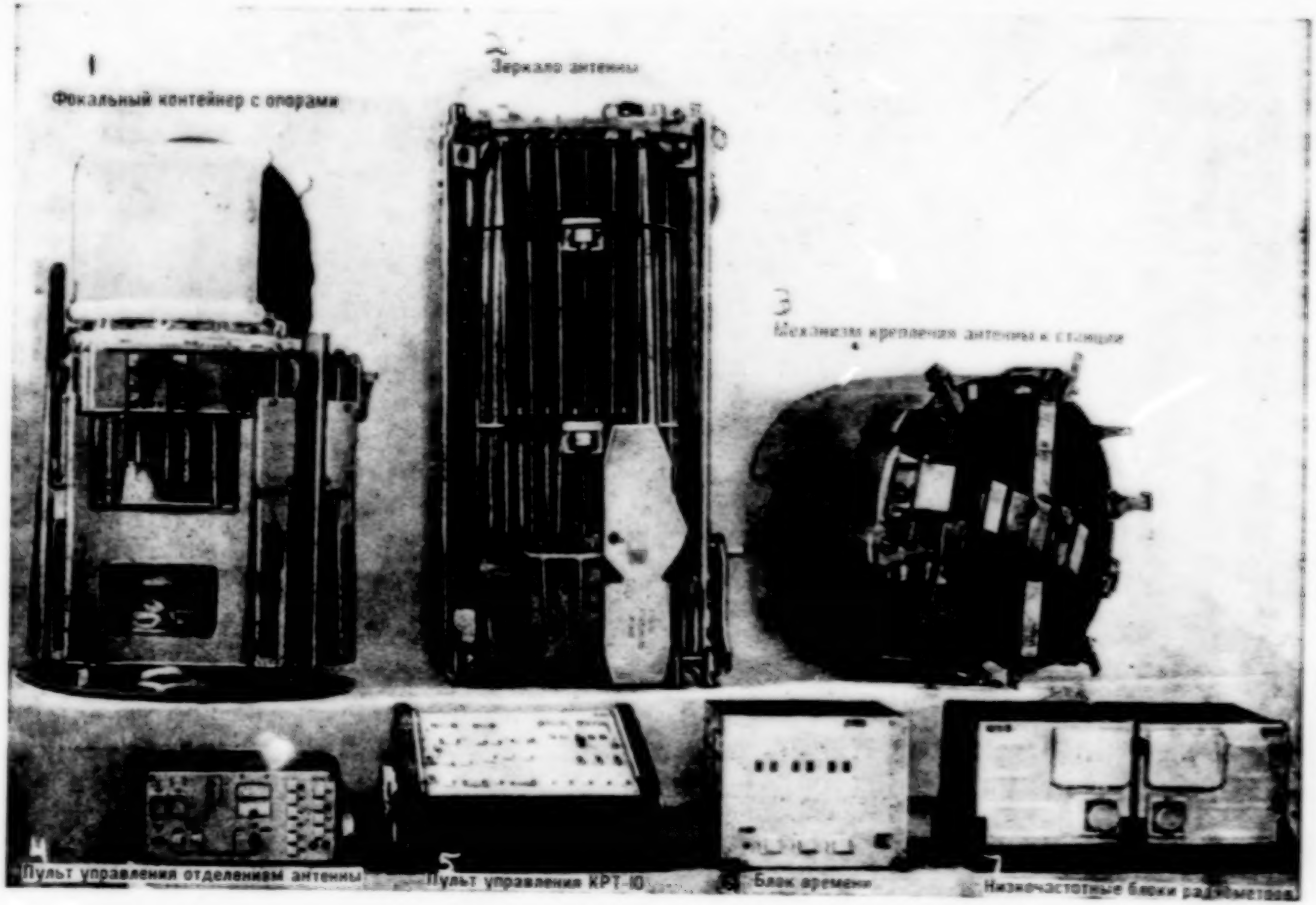
Thus, the main prospects for radio astronomy are related to increasing the area of the antennas and spacing them at ever increasing distances apart. Both of these have practically unlimited possibilities in the design of space radio telescopes.

The first step in space radio astronomy is the placement of a small radio telescope in a not very high orbit. What experiments can be formulated in this case? The atmosphere of the earth is practically transparent to radio waves in a frequency range from 1 cm to 30 m. For this reason, a radio telescope in space, traveling in a low orbit, forms and interferometer with any ground based radio telescope, the baseline of which changes rapidly and continuously with time. And this is already an important new quality which is impossible to obtain by means of the same purely ground base system. The major requirement for radio interferometry reads as follows: to obtain a high quality image of the source being studied with the maximum possible angular resolution, it is essential to make observations at all values of the baseline length from the minimum to the maximum and at all possible orientations of the baseline. This requirement is met during the travel of the low orbiting space radio telescope. The angular resolution of space interferometers increases in step with the increasing size of the orbit. The utilization of interferometers with baselines in space makes it possible to change over to qualitatively new methods of research. One of these methods is the derivation of three dimensional images of the sources being studied: space radio holography. The realization of this method is related to the possibility of measuring the curvature of the incoming radio wave front. The maximum distance to the source being studied is determined by the square of the interferometer baseline, divided by the wavelength. With baselines on the order of the diameter of the earth, it is less than the distance to the nearest stars, but with interferometer dimensions of several astronomical units, this distance rapidly increases up to dimensions which are comparable with the radius of curvature of the universe. For this reason, the significance of holographic methods will be greater, the greater the orbital dimensions become.



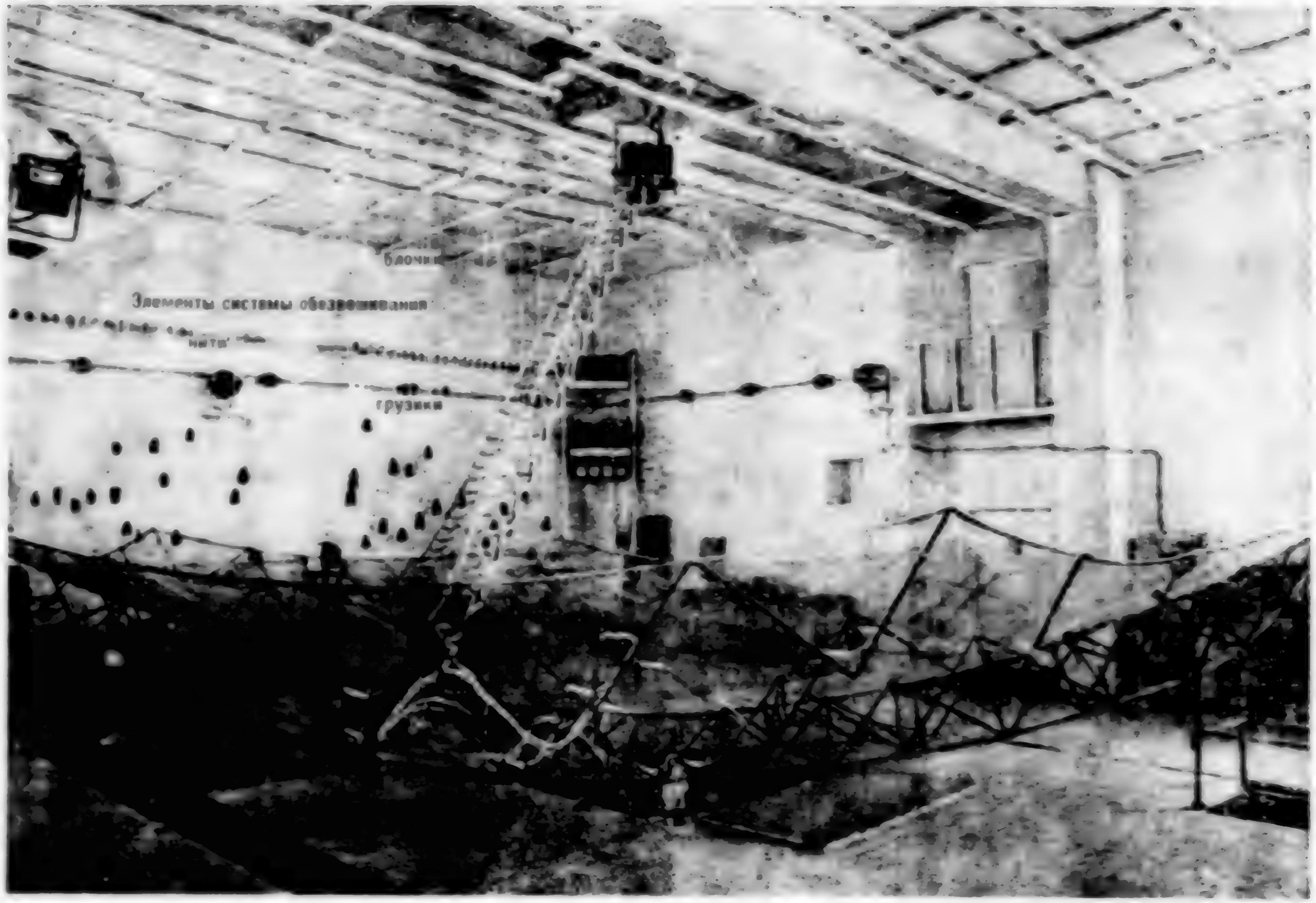
Schematic of an interferometer with a variable baseline.

Key: 1. Radio emission source;
2. Radio telescope in space;
3. Resulting radio image;
4. Ground radio telescope.


1
Фокальный контейнер с опорами
2
Зеркало антенны
3
Механизм крепления антенны к станции
4
Пульт управления отделением антенны
5
Пульт управления КРТ-10
6
Блок времени
7
Низкочастотные блоки радиометров

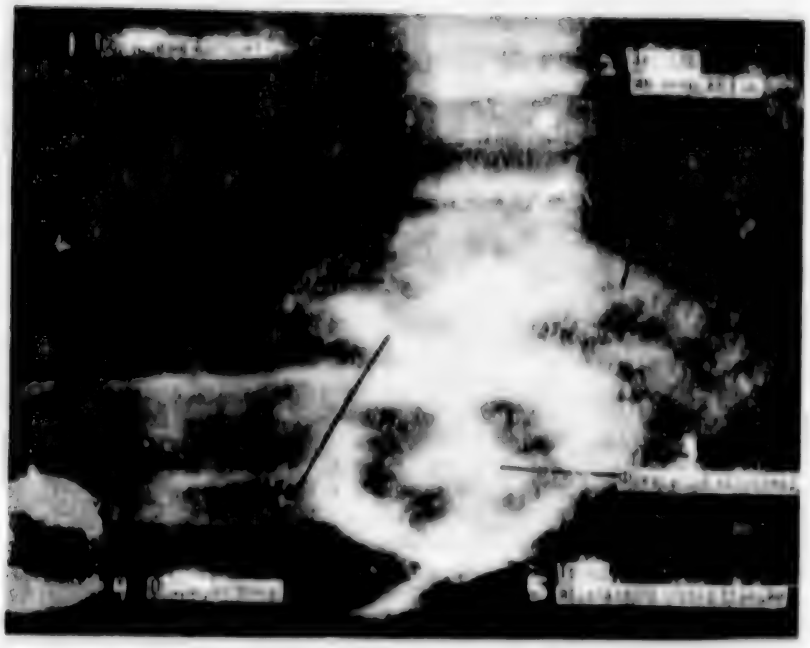
The KRT-10 equipment set up for transport (folded up).

Key: 1. Focal container with supports;
2. Antenna reflector;
3. Mechanism for securing the antenna to the station;
4. Control panel for the antenna compartment;
5. KRT-10 control console;
6. Time block;
7. Low frequency radiometers.



The KRT-10 antenna unfolded in the testing room.

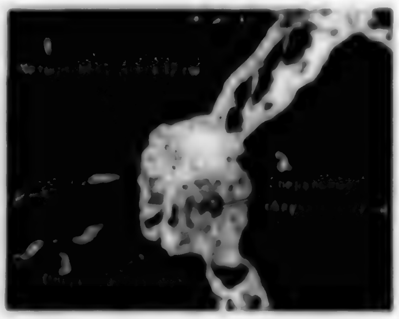
Key: 1. Small pulleys;
2. The elements of the weightless simulation system;
3. Wires;
4. Weights.



A photograph of the 'Salyut-6" station taken by the television camera on the departing "Progress-7" ship following the deployment of the KRT-10 antenna. The lower part of the reflector and the right support of the antenna, just as the right side solar battery, are not visible in the photograph because of the lighting conditions.

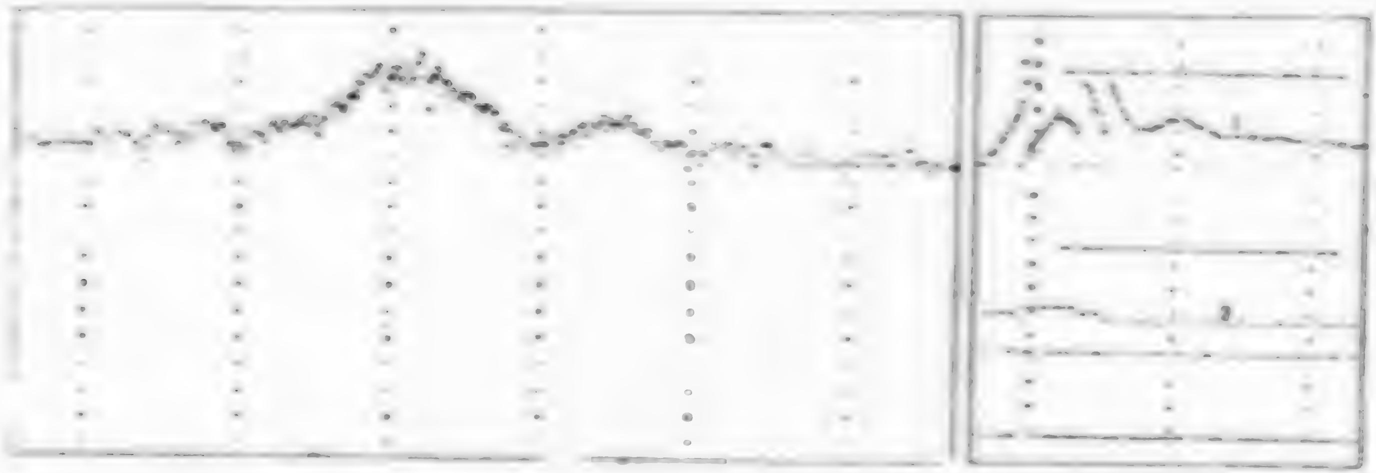
Key: 1. Solar batteries;
2. The reflector of the KRT-10 antenna;
3. Focal container;
4. Antenna supports;
5. End face of the equipment compartment of the station.

Yet another new method is the observation of the flickering of radio source Similar to the flickerings of stars visible to the naked eye and due to density fluctuations in the earth's atmosphere, the flow of radio emission from a distant compact radio source experiences chaotic fluctuations which are related to density fluctuations in the interstellar plasma. Studies of this phenomenon have shown that the interstellar medium takes the form of an aggregate of a large number of plasma clouds of different sizes, traveling at different velocities. Each cloud chaotically focuses (or defocuses) the radio wave passing through it. The rays passing through the different clouds can intersect and interfer with one another. The flickering of radio sources is due to this changing chaotic interferometric picture. The determination of the characteristic dimensions of such an interference pattern and its rate of change will probably open up a new approach to the study of the nebular structure of the interstellar plasma, its rates of motion as well as to the study of the radiation sources themselves using exceptionally high angular resolution. Imagine the image plane of the observer (i.e., the plane in which the observer is located, perpendicular to the direction to the source being studied). Observations show that because of the flickering effect, the level of radiation flux from a source at different points in this plane will be different and the entire picture of the radio emission flux distribution over the plane is shifted on the whole in some definite direction. At the same time, the structure of the picture almost does not change with time. This motion is also perceived by a single radio telescope as flickering of the radio source. Two radio telescopes operating simultaneously can measure the characteristic size of the image and its rate of travel along the baseline between the antenna. Three radio telescopes operating simultaneously can measure the image size in two directions as well as the instantaneous velocity vector of its travel. A larger number of simultaneously operating radio telescopes makes it possible to also detect the change in the structure of the image. Thus, the utilization of the speckle method for the determination of the parameters of the interference picture requries that a minimum of two radio telescopes operate at the same time. In the speckle method just as in interferometry, it is important that one of the telescopes travel rapidly in orbit. The change in the size and orientation of the baseline makes it possible to single out different dimensions and directions of travel in the image. The angular resolution of such a method is determined by the ratio of the characteristic size of the speckle picture to the distance to the source. It is much greater than the resolution of interferometers and is equal to 10^{-7} - 10^{-8} angular seconds for distances of a few kiloparsecs from the sun. For this reason, flickering is as yet observed on for pulsars (the most compact of the known radio sources).

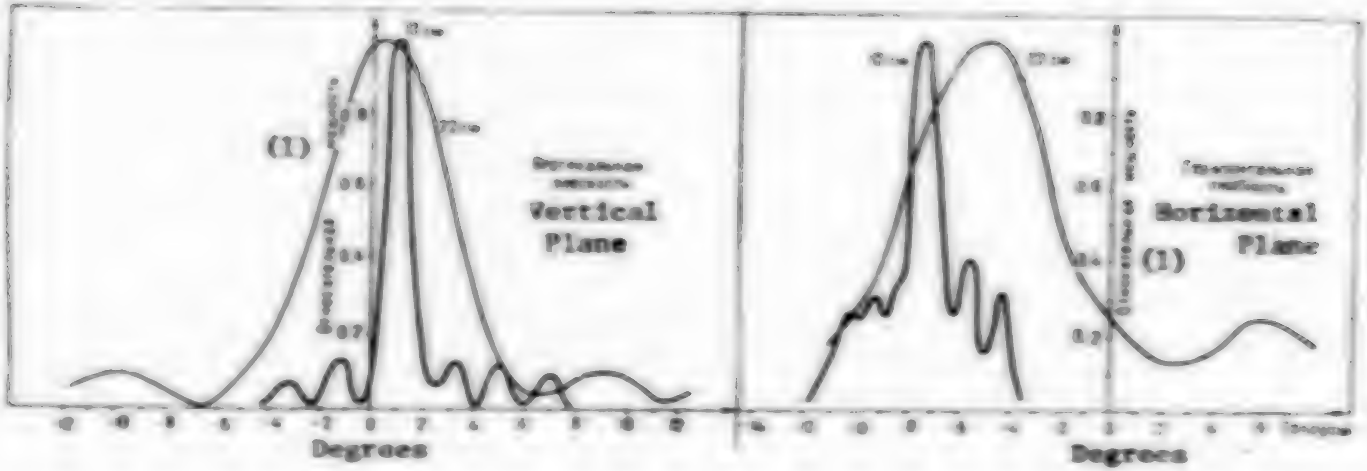


Photograph of the irradiator of the KRT-10 antenna obtained following the deployment of the antenna by means of the docking television camera of the "Salyut-6" station through the structure and the reflective netting.

Key: 1. The four 12 cm irradiators;
2. The helical 72 cm irradiator;
3. Supports with the cables.

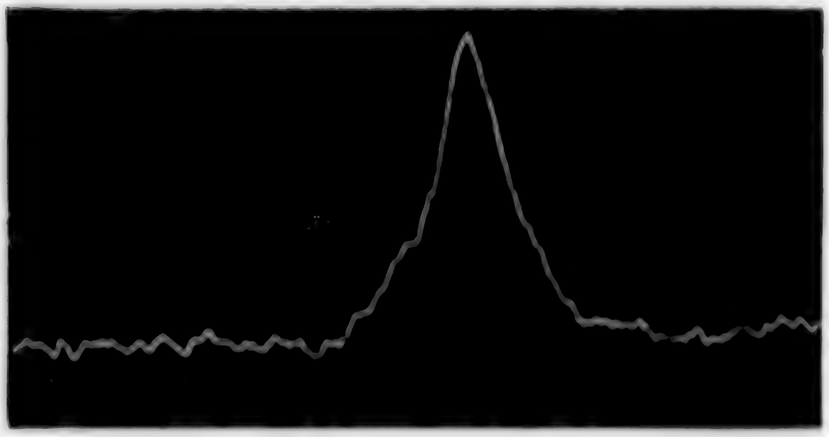


Examples of recordings of telemetry data transmitted to earth during the process of measuring the characteristics of the KRT-10 antenna. Time is plotted along the horizontal and the power received by the antenna is plotted along the vertical. On the left is the recording of signals from the discrete radio emission source Cassiopeia A in the 12 cm band; on the right is the recording of signals from the sun in the 72 cm band. Since the variation in the signal is quite large, the range of one fine scale proved to be inadequate and it was necessary to change from one fine scale over to another. 1 is the fine scale reading of the radiometer; 2 is the discrete signal indicating the number of the fine scale, within the limits of which the measurement signal falls.

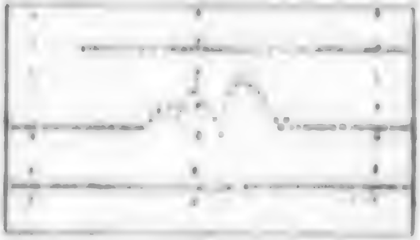


The power received by the KRT-10 antenna as a function of the angle between the longitudinal axis of the "Salyut-6" station and the direction to the emission source: the directional pattern. It was obtained as a result of processing the telemetry data transmitted to the earth and is shown in the form of two cross-sections in mutually perpendicular planes.

Key: 1. Relative power.



A pulse from the pulsar PSR 0329+54, received by the ground-based radio telescope of the Deep Space Communications Center in the Crimea on August 6th, 1979 during synchronous operation with the KRT-10.



The recording of signals in the 12 cm band obtained when one of the beams of the KRT-10 antenna passed throgh the active Mt. Etna volcano.

Observations of the pulsar PSR 0329+54 by two radio telescopes in England and Canada simultaneously at a frequency of 408 MHz made it possible to estimate the size of the flickering image: about 80,000 km (that is, much larger than the dimater of the earth), while the rate of travel in the image plane was about 360 km/sec.

The methods considered here do not exhaust all of the possibilities which radio telescopes in space have for radio astronomy research. Radio telescopes in space make it possible to receive signal without the distortion or strong attenuation by them of the atmosphere, something which is especially important in studies in the millimeter and decameter bands.

THE KRT-10 Equipment

The KRT-10 is the first space borne radio telescope in the world, having a deployable reflector antenna with a diameter of 10 m. It is composed of individual units in the long term orbital station. The KRT-10 is designed for receiving weak electromagnetic signals incoming from outer space, the surface of the earth, the world's oceans and the atmosphere of our planet in the 12 and 72 cm bands. Because of the large diameter of the reflector of the antenna, the KRT-10 provides for a resolution on the earth of 7 km in the 12 cm band from an altitude of 400 km.

The capability of training the KRT-10 on remote space radio sources and receiving signals from simultaneously with a ground radio telescope makes it possible to form a two element system with a baseline which changes with time. The length of the baseline is somewhat greater than the diameter of the earth.

The assembly of the KRT1-10 by V.A. Lyakhov and V.V. Ryumin from the individual units, as well as the installation of the entire radio system, the deployment and unfolding of the antenna, the adjustment of the signal levels of the radiometers, the guidance of the KRT-10 on the objects being studied by means of precise orientation of the station with respect to stars as well as the control of its motion, and the operationally timely transmission of data to the earth significantly expand the technical capabilities of the equipment.

The KRT-10 consists of a five beam two band pencil beam reflector antenna, a five channel two-band highly sensitive radiometer, a time block, a control console, the equipment and control panel for separating the antenna from the station as well as the connecting cables.

As regards the transportation in the cargo supply ship, the antenna was broken down into three blocks: the rotating reflector, the focal container with the feed horns and three extendable supports, as well as the mechanism for securing the antenna to the "Salyut-6" station. In the folded-up (transport) state, the reflector takes the form of a hexahedral prism with a maximum transverse dimension of about 0.5 m. In the deployed state it is a regular hexagon with a side of 5 m, i.e., with a maximum dimension of 10 m. The ratio of the dimensions of the antenna reflector when deployed and when folded up (the unflding ratio) is about 20. There has never been such an unfolding ratio in any of the known structural designs for collapsible antennas.

The antenna reflector takes the form of a spatial structure composed of trusses which form two equidistant surfaces. Both surfaces of the structure are produced by tensioned stranded wires 1 mm in diameter. The stranded wires are connected at the junction nodes with spring loaded mechanisms to form triangular cells. The maximum dimension of a cell is slightly more than 1 m. The surfaces are joined together by rigid diagonal bars with a rectangular cross-section of 6×12 mm^2 and a length of about 0.8 m. The requisite configuration of the working surface is determined by the length of the stranded wires.

The reflecting surface of the reflector is a specially designed woven netting made of metallic filaments 50 um in diameter. To improve the reflection factor, the netting array was coated with a thin layer of metal having an electrical conductivity higher than that of the main metallic filaments.

The antenna irradiators are four horns for the 12 cm band and a helical feed for the 72 cm band and are mounted on the framework of the focal container, inside the hermetically sealed compartment of which the high frequency amplifiers of the radiometers and the thermal control system are located. The focal container is mechanically connected to the reflector by three folding supports. When unfolded, each support takes the form of a triangular truss 5 m long. When folded, the support length is 0.27 m. The cable connecting the equipment of the focal container and several transducers positioned on the antenna to the equipment installed in the working compartment of the station are run along the supports and through the structures of the reflector.

The low frequency radiometers, which are colocated with the control console for the KRT-10, the time block and the control panel for the antenna compartment in the working compartment of the station, make it possible to transmit data to ground via conventional telemetry links.

The working out of the deployment of the antenna deflector and the supports of the focal container was of enormous importance in the design of the KRT-10. This was done at first using a fragment of the antenna, and then repeatedly tested on the entire antenna. These tests were performed on a specially designed test stand with a system for compensating for the weight of the structural components of the antenna, simulating the conditions of weightlessness.

The Experiments On Board the "Salyut-6"

On June 30th, 1979, the "Progress-7" cargo ship delivered the KRT-10 modules to the "Salyut-6" station. Cosmonauts V.A. Lyakhov and V.V. Ryumin carried out the docking and the assembly of all of the modules, preliminarily checking the operation of the individual components.

On July 18th, 1979, the "Progress-7" departed the station and the KRT-10 antenna was deployed and opened out. The television cameras on board the "Progress-7" made it possible to observe the process of antenna deployment.

The KRT-10 operated until August 9th, 1979, when the antenna was separated from the station (ZEMLYA I VSELENNAYA, 1979, No 6, pp 2-3, ed.). An analysis of the received telemetry data, as well as the regular reports of the crew attested to the fact that the equipment was delivered on board the station in good working order and functioned flawlessly.

The values of the fluctuating sensitivity of the on board radiometers corresponded to the design figures of 0.2--0.3 °K and practically did not change during the entire operation.

When the KRT-10 was placed in service on board the "Salyut-6" station, the most important stages were the adjustment and recording of the directional patterns of the antenna. The alignment (the referencing of the antenna beams to the major axes of the station) was necessary for the performance of all the subsequent experiments. The directional patterns are especially important for the evaluation of the actual resolving power, and moreover, they provide reliable data on the quality of the antenna deployment. The cosmonauts had to rotate the entire station for these measurements. The measurements were made based on the radio emission of the discrete source Cassiopeia A, the sun and a ground source. The results of the alignment were in good agreement with the data on the position of the center of the helical irradiator, obtained using the docking television camera of the station. This indicates that the aperture plane of the antenna reflector was perpendicular to the longitudinal axis of the station. The measured directional patterns likewise attest to the good quality of the atenna deployment. As was anticipated, a beam width of 1 to 1.3° was obtained at a wavelength of 12 cm. The width of the directional pattern at 72 cm was 5.5 to 6°. Thus, the requisite material for subsequent experimental research was obtained.

Astrophysical studies, the task of which was the working out of radio astronomical methods in space, were performed in two modes: circular rotation of the station about the transverse axis for mapping the Milky Way and fixed orientation of the station for observing the pulsar PSR 0329+54 in conjunction with the 70 meter radio telescope in the Crimea.

A large number of geophysical studies were performed. A fundamentally new result was the high resolving power previously achieved by no one in measurements of the radio brightness temperature of the earth and the world ocean from space. Of the unusual phenomena, one can note the radiation from the Mt. Etna volcano which became active at that time and was registered by the KRT-10.

The creation of the KRT-10 space borne radio telescope and the radio engineering astrophysical and geophysical research performed with it represent a new step in the development of domestic science and engineering.

One can say with confidence that now the way is open towards the design of space borne radio engineering systems with large highly directional antennas installed in orbit, where these antenna operate both independently and in conjunction with ground radio telescopes. The following work which was performed during the design of the KRT-10 is extremely important in the development of this direction in science and engineering: the study of the applications areas of space borne radio systems with large highly directional antennas which are installed in orbit; the working out of the design principles for the electrical circuits and various types of structures for such systems; the investigation of the fabrication technology for large collapsible antennas and their testing under ground conditions; the development of methods for installing space borne radio systems with large collapsible antennas when in orbit and placing them in service.

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SPACE SCIENCES

EFFECT OF MULTIPLE SCATTERING ON THE EFFECTIVENESS OF REGISTRY OF ELECTRONS BY TELESCOPES OF DETECTORS

Moscow GEOMAGNETIZM I AERONOMIYA in Russian No 3, 1980 pp 541-543

LUPENKO, G. V., Nuclear Physics Institute, Moscow State University

[Abstract] Telescopes of detectors are commonly used in cosmic ray registry. The literature describes different types of telescopes and gives expressions for their geometrical factors depending on the dimensions of the detectors and the distance between them. In these computations it has been assumed that the telescopes register particles which are not scattered in the substance of the detectors and construction parts of the telescope. This is correct for protons, nuclei and high-energy relativistic electrons. But in an investigation of low-energy relativistic particles it is necessary to take into account the multiple scattering of particles in computing the geometrical factor and the effectiveness of the telescope because the electrons entering the telescope within the limits of its aperture angle, as a result of scattering, can emerge from it, and vice versa, electrons outside the solid angle of the instrument can enter it and be registered by the telescope. In exploring this problem, the author examines the results of computation of the product $\Gamma\varepsilon$ [Γ is the geometrical factor, is registry effectiveness] by the Monte Carlo method for a telescope registering low-energy relativistic electrons, taking the role of multiple scattering into account. The computations were made using the parameters of the telescope registering electrons on the "Prognoz-4" and "Prognoz-5" satellites. The exact character of this multiple scattering is determined. This in-depth analysis confirms that multiple scattering must be taken into account when determining the geometrical factors, effectiveness and directional properties of telescopes registering low-energy relativistic electrons. Figures 2; references: 4 Russian.
[346-5303]

DECIMETER RADIO EMISSION OF CIRCUMTERRESTRIAL SPACE DURING MANIFESTATIONS OF SOLAR ACTIVITY

Moscow GEOMAGNETIZM I AERONOMIYA in Russian Vol 20 No 3, 1980 pp 482-488

MUSATENKO, S. I., Kiev State University

[Abstract] The literature contains references to coincidence of bursts of radio emission in circumterrestrial space (CTRE) and chromospheric flares and solar radio emission bursts. In virtually all cases such coincidences were registered at auroral or subauroral latitudes. The author here gives the results of investigation of CTRE bursts in the decimeter range observed in the middle latitudes during the years 1975-1977 near the commencement and during chromospheric flares and the relationship between CTRE and bursts of solar radio emission in the centimeter and decimeter ranges. Observations were made at frequencies 189 and 500 MHz. CTRE bursts appear 5-10 minutes before the commencement of a flare or solar radio emission burst. A high percentage of such CTRE bursts is wide-band, that is, is observed simultaneously at 189 and 550 MHz. All observational data were divided into three solar activity periods. During the observation period there were about 1,300 chromospheric flares and more than 200 sudden ionospheric disturbances (SID). An increase in the density of bursts begins 13-14 minutes before the commencement of a flare in the optical spectral region. The density of CTRE bursts coinciding with SID (and with flares giving rise to SID) is considerably greater than the density of bursts associated with all flares. A comparison of CTRE in the decimeter range with solar radio emission bursts indicates that these events very frequently coincide. For all the considered events there is a maximum in the afternoon and evening hours local time. The considered events are dependent on solar zenith distance and there should be "sunrise-sunset" effects in CTRE. A study of the dependence of CTRE on longitude of a solar flare revealed an appreciable asymmetry of the solar eastern and western hemispheres. The mean duration of CTRE bursts is 1.0-1.5 minutes. During very low activity there is a decrease in mean duration, whereas during high activity there is an increase. A study of CTRE burst structure indicates that they develop under the influence of the pulsed component of hard solar radiation. This component is characteristic for hard solar x- and UV-radiations during flares. CTRE bursts which are observed before the commencement of a flare in Hα arise under the influence of UV radiation, whereas those coinciding with the commencement of the appearance of radiation and prior to the maximum of the flare in Hα arise under the influence of x- and UV-radiations. Figures 4; tables 1; references 19: 11 Russian, 8 Western.
[346-5303]

UDC 629.78:612.111/112.014.2

HEMATOLOGICAL ASPECTS OF SPACEFLIGHT, REPORT I: CYTOLOGICAL CHARACTERISTICS OF PERIPHERAL BLOOD

Moscow PROBLEMY GEMATOLOGII I PERELIVANIYA KROVI in Russian Vol 25, No 5, May 80 pp 28-36 manuscript received 4 Oct 79

GAVRILOV, O. K., corresponding member, USSR Academy of Medical Sciences, KOZINETS, G. I., BYKOVA, I. A., SHISHKANOVA, Z. G., MATVIYENKO, V. P., RYAPOLOVA, I. V., DUL'TSINA, S. M., BORZOVA, L. V., KUL'MAN, R. A., DYAGILEVA, O. A., TALELENOVA, N. N., KOVNER, V. Ya., and KOTEL'NIKOV, V. M.

[Abstract] The authors discuss the changes that took place in the blood of eight cosmonauts, four of whom completed 8-day spaceflights, while two each completed 96- and 140-day flights. Their main attention is focused on changes affecting erythrocytes and leucocytes, although granulacytes and reticulocytes are also briefly discussed. They conclude that all the changes they noted were not pathological, but were probably caused by the fact that the cosmonauts' bodies had to adapt to the conditions encountered in space (primary weightlessness) and then readapt to terrestrial conditions. Figures 11; references 18: 13 Russian, 5 Western.
[335-11746]

UDC 575.24:595.773.4

EFFECT OF THE DYNAMIC FACTORS OF SPACEFLIGHT ON THE MUTAGENIC EFFECT OF RADIATION, REPORT I: THE APPEARANCE OF DOMINANT LETHAL MUTATIONS IN THE OOGENESIS OF DROSOPHILA MELANOGASTER

Moscow GENETIKA in Russian Vol 16, No 4, Apr 80 pp 650-655 manuscript received 1 Mar 79

KOGAN, I. G., and CHZHAN, T. I., Institute of General Genetics, USSR Academy of Sciences, Moscow

[Abstract] The basic harmful factor encountered during spaceflight is radiation, the effects of which are modified by the dynamic factors of vibration and acceleration. The interaction of these factors is clearly understood, so the authors planned a data-gathering experiment to determine the frequency of dominant lethal mutations arising after the 7th and 14th stages of Drosophila melanogaster [illegible]tes are exposed to gamma-radiation and the dynamic factors. They con[illegible] that the somewhat contradictory results obtained during model and airborne experiments involving exposure to radiation are caused by different radiation sensitivity at different stages of gametogenesis and the modifying effect of the dynamic factors on immature reproductive cells. Basically, the more mature the reproductive cell, the less effect the dynamic factors have. Figures 2; references 14: 8 Russian, 6 Western.
[341-11746]

UDC 612.74:612.135]-06:612.766.2

CAPILLARY BED OF SKELETAL MUSCLES IN HYPOKINESIA

Moscow BYULLETEN' EKSPERIMENTAL'NOY BIOLOGII I MEDITSINY in Russian No 4, 1980 pp 408-410 manuscript received 30 Apr 79

KAPLANSKIY, A. S., DURNOVA, G. N., and MAILYAN, E. S., Institute of Medicobiological Problems, USSR Ministry of Health, Moscow

[Abstract] The authors present the results of a quantitative histological study of the microcirculatory muscle bed of the rear extremities of hypokinetic rats. Their experiment involved 20 white rats weighing 240 g each, of which 10 were kept under conditions of hypokinesis, while the other 10 could move normally and were used as controls. They conclude that the blood supply level of "red" muscle fibers (with an oxidative type of exchange) varies more with activity and inactivity than does that of "white" ones (with a glycolytic type of exchange). Hypokinesis leads to atrophy of the red muscle fibers and a lowering of their blood supply level, which is accompanied by a reduction in the number of capillaries supplying them with blood. Figures 3; references 10.
[342-11746]

SPACE ENGINEERING

UDC 62-50

SYNTHESIZING THE "EKRAN" ROLL AND DIRECTION SATELLITE ORIENTATION AND STABILIZATION SYSTEM

Moscow TEKHNICHESKAYA KIBERNETIKA in Russian No 6, Nov-Dec 79 pp 36-45 manuscript received 30 Apr 78

KALINOVICH, S. N., MARKELOV, G. M., and RAYEVSKIY, V. A., Moscow

[Abstract] The roll and direction satellite orientation and stabilization system for the "Ekran" television broadcast satellite is distinguished by the use of a gyrostabilizer with uniaxial suspension. Roll control is carried out with the help of a moment sensor on the precession axis, while directional control is implemented by means of a gyroscope connection between the roll and direction channels. The authors model the performance of this system on a computer for the purpose of determining its optimum parameters. Their initial model is for an absolutely rigid satellite, but they then extend it to include a satellite with some degree of elasticity (because of solar batteries that are attached to it). This system has been tested under flight conditions, and its roll orientation accuracy is ±10'. Figures 12; references 1.
[292-11746]

UDC 629.197.2

ON ONE CONTROL ALGORITHM FOR THE FINAL STAGE OF A DESCENT FROM ORBIT

Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 18, No 2, Mar-Apr 80 pp 173-177 manuscript received 25 Dec 78

APPAZOV, R. F., VINOGRADOVA, G. A., VOYEVODIN, S [illegible], and KAMENKOV, Ye. F.

[Abstract] The authors study the flight of a spacecraft during the final stage of its descent and derive an algorithm for controlling it that is based on its bank angle. To do this they use the principles of remote guidance, with particular emphasis on homing on a radar beacon by the method of proportional convergence. Statistical modeling of the algorithm shows that a spacecraft can be landed with 0.7 km of a given point even when there are significant deviations in the initial conditions, the spacecraft's aerodynamic characteristics and the density of the atmosphere. Figures 2; references 3.
[317-11746]

UDC 631.]8

CONTROLLING REDUNDANT GYROPOWERED SYSTEMS

Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 18, No 2, Mar-Apr 80
pp 147-156 manuscript received 10 Dec 79

TOKAR', Ye. N., LEGOSTAYEV, V. P., MIKHAYLOV, M. V., and PLATONOV, V. N.

[Abstract] The authors discuss the case of a spacecraft with a powered gyroscopic system containing an arbitrary number of gyroscopes; this system differs from a classical three-stage gyropowered stabilization system in that the angles of rotation of the gyroassemblies around the axes of the suspensions are practically unlimited and that such a system has a high degree of redundancy. They discuss the cases of single-rotor two- and three-stage stabilizers. By breaking the control vector into two components, they show that one of them defines the gyroscope system's control moment formulation law, while the other realizes some extreme control law for the system and causes redistribution of the kinetic moment among the individual gyroscopes. Figures 4; references 8: 7 Russian, 1 Western.
[317-11746]

UDC 528.722:681.34

CORRELATION PROCESSING OF SCAN SIGNALS OF AERIAL STEREOSCOPIC IMAGE

Moscow IZVESTIYA VUZ, GEODEZIYA I AEROFOTOS"YEMKA in Russian No 2, 1980
pp 71-75 manuscript received 7 Aug 78

MYSHLYAYEV, V. A., candidate of engineering sciences and TELEKOVETS, V. A., engineer

[Abstract] The article presents a description of the logic of the operation and schematic diagrams of a scan signal processing unit, developed by the authors and manufactured by the Taganrog Electrical Engineering Institute imeni V. D. Kalmykov for a working model of a system that automatically identifies like points on aerial photographs of a stereoscopic image. The scan signal processor is a special digital computer with a correlator, extremum extractor, control system, processor, printout and oscillograph. The correlator computes the cross-correlation function. To the correlator inputs are fed analog scan signals, proportional to the optical densities of the left and right aerial photographs of a stereoscopic image, which are centered and converted to sign functions. The values of a sign function are delayed by the initial delay register of the correlator for the time necessary for computing the cross-correlation function for both positive and negative argument values. The correlator reads out all CCF values in analog form on the screen of the oscillograph for visual observation and 15 average values in digital form to the extremum extractor. Figures 3: references: 3 Russian.
[347-7872]

UDC 681.113.93.+681.116

SMALL QUARTZ CLOCKS FOR UNIFIED TIME SERVICE SYSTEM IN PHOTOASTRONOMICAL METERING COMPLEXES

Moscow IZVESTIYA VUZ, GEODEZIYA I AEROFOTOS"YEMKA in Russian No 2, 1980
pp 98-103 manuscript received 6 Jul 78

BEREGOV, B. S., engineer

[Abstract] The author proposes and develops small-scale quartz clocks, intended for storing precision time and for synchronizing photoastronomical instruments located at great distances from each other, and for astronomical determinations of longitudes, latitudes and azimuths in geodetic work. A functional diagram of the small quartz clocks is shown. The clocks consist of a local time scale storage, referencing system and power unit. The reference frequency source of the local time scale storage is a 5 MHz reference oscillator. The quartz clocks are powered from the industrial AC line and are backed up by storage batteries. The precision characteristics of the quartz clocks in joint operation with the "Volna-K" radio receiver and S1-49 electron beam oscillograph are given. Figures 3; references: 2 Russian.
[347-7872]

UDC 535.215+53.082.52

RESULTS OF STUDIES OF SCANNING SYSTEM FOR MONITORING RECTILINEARITY

Moscow IZVESTIYA VUZ, GEODEZIYA I AEROFOTOS"YEMKA in Russian No 2, 1980
pp 93-97 manuscript received 20 Sep 79

ZHILKIN, A. M., reader, candidate of engineering sciences, Moscow Order of Lenin Institute of Geodetic, Aerial Photographic and Cartographic Engineers

[Abstract] A special automatic reference beam stabilization system was developed by MIIGAiK [Moscow Order of Lenin Institute of Geodetic, Aerial Photographic and Cartographic Engineers] for the purpose of improving the efficiency of photoelectric rectilinearity monitoring instruments. The optical signal processing technique employed in goniometers is utilized. Reference laser beam formation techniques that maximize the uniformity of measurement sensitivity along a line are investigated theoretically and experimentally. The studies show that the use of an optical correlator as the photoelectric transverse displacement analyzer is an effective means of reducing the influence of reference beam instabilities on measurement precision. Figures 1; references: 11 Russian.
[347-7872]

UDC 528.913+528.235

EXTERNAL AERIAL PERSPECTIVE AZIMUTHAL CARTOGRAPHIC PROJECTIONS OF ELLIPSOID WITH POSITIVE IMAGE (PROJECTIONS OF SPACE PHOTOGRAPHS OF CELESTIAL SURFACES)

Moscow IZVESTIYA VUZ, GEODEZIYA I AEROFOTOS"YEMKA in Russian No 2, 1980
pp 85-92 manuscript received 11 Aug 78

BUGAYEVSKIY, L. M., doctor of engineering sciences, Moscow Order of Lenin Institute of Geodetic, Aerial Photographic and Cartographic Engineers

[Abstract] Formulas are derived in the article for the external aerial perspective azimuthal projection of an ellipsoid with a positive image in consideration of all reference elements, which make it possible to convert from geodetic coordinates to polar spheroidal coordinates with the pole in a given position, and then to Cartesian coordinates of projection and back, and to compute the scales and distortions of those projections. Terms up to e^4 inclusively are retained in all the formulas. In the absence of polar compression the formulas derived acquire the form of the corresponding formulas of the projections of a sphere, in which all reference elements are also taken into consideration. An analysis of the formulas establishes cases when it is possible to obtain and utilize perspective azimuthal cartographic projections with positive imaging without having to consider the amount of polar compression of the earth ellipsoid. With the formulas it is possible to compute to an accuracy sufficient for most practical cases the scales of the lengths not only for points on the main vertical, but also for all points of projection. Nadir distortions occur only because of the inclination of the image plane, at the zero distortion point only because of the spheroidicity of the image plane, and at the main point, as at all other points of projection, only because of the influence of both factors. Figures 1; references: 2 Russian.
[347-7872]

SPACE APPLICATIONS

EVALUATING ONE CLASS OF LINEAR-FRACTIONAL REPRESENTATIONS OF REMOTE SENSING OPTICAL SIGNALS

Moscow ISSLEDOVANIYE ZEMLI IZ KOSMOSA in Russian No 3, 1980 pp 84-90

MUKHAMEDYAROV, R. D., Space Research Institute, USSR Academy of Sciences

[Abstract] In the analysis and synthesis of optoelectronic systems constituting part of the complex spectroradiometric instrumentation aboard space vehicles, the need arises to identify optical signals under very difficult conditions and the system must be optimized with respect to noise immunity to both internal and external interference (spatial filtering must be provided). For solving the problem the author here proposes the use of one class of linear-fractional representation operators in the creation of optoelectronic systems with a symmetric input, invariant to changes in the intensity of the radiation and interference received. The article gives an example of practical application of the approach and evaluates the method for widely occurring interference of the Rayleigh type. It is shown that the proposed method for ensuring invariance of the identification system will be the more effective the better the correlated interference is simultaneously fed to both symmetric inputs. The introduction of an additional channel with an independent input for the parameter to be measured is only one of the necessary conditions for identification invariance. Other requirements include additional connections between the two channels and a guarantee of the proper parameters for the range and linearity of the measurement channels. (Figure 1 in the text is a block diagram of the proposed system.) Figures 2; references: 17 Russian.
[353-5303]

TRAJECTORIES OF SPACE VEHICLES INTENDED FOR INVESTIGATION OF THE EARTH FROM SPACE

Moscow ISSLEDOVANIYE ZEMLI IZ KOSMOSA in Russian No 3, 1980 pp 91-97

LUKASHEVICH, Ye. L., "Priroda" State Scientific Research and Production Center

[Abstract] Space vehicle trajectories in near-earth space must be selected in such a way as to make possible an orderly scanning of the entire planetary surface or a stipulated spherical zone during a relatively short time period, taking into account a number of specific requirements on differences in scale of the collected information, on periodicity of repeated observations of the same regions, on illumination of the earth's surface, etc. The author here presents the characteristics of trajectories of space vehicles which satisfy these requirements, followed by an examination of methods for computing the nominal parameters of these trajectories. Also considered are such methods as interorbital maneuvering and reduction of the orbital semimajor axis, which decreases under the influence of the atmosphere, to a computed value, as well as methods for calculating the active segments of interorbital transfers by means of low-thrust jet engines. All the formulas presented in this article were derived with an accuracy to terms of the order of the earth's flattening, which entirely satisfies the accuracy requirements in the stage of ballistic planning of space vehicles. All the presented formulas are easily programmed and do not require great amounts of computer time. References 7: 6 Russian, 1 Western.
[353-5303]

STRUCTURE OF A SPACE SYSTEM FOR STUDYING THE EARTH'S NATURAL RESOURCES

Moscow ISSLEDOVANIYE ZEMLI IZ KOSMOSA in Russian No 2, 1980 pp 5-10

KIYENKO, Yu. P., "Priroda" State Scientific Research and Production Center

[Abstract] In the USSR two specialized centers have been established for the development of two closely interrelated and, at the same time, autonomous directions in the collection and exploitation of remote sensing data (operational and long-term): the State Scientific Research Center for the Study of Natural Resources and the State Scientific Research and Production Center "Priroda." These centers are charged with the task of collecting, interdisciplinary processing, storage and dissemination of space information for operational and long-term purposes respectively. The solution of scientific-methodological problems in studying the earth from space is accomplished at the USSR Space Research Institute in interaction with a number of organizations and institutes in the country. The national space system for the study of natural resources and the environment includes: manned space vehicles; space vehicles of the "Meteor" type; space vehicles of the "Cosmos" series; aircraft-laboratories; ground means for the reception and interdisciplinary processing of data; a network of ground and sea polygons outfitted with mobile and stationary means for contact and near-surface measurements; a network of means and systems for information processing by discipline. The purpose of the components mentioned is discussed in some detail. The national plans include work on the use of space surveys in geological investigations of extensive regions of the country; mapping of remote regions and revision of topographic maps; study of forest resources; development of plans for major engineering structures, including hydroelectric power stations, petroleum and gas pipelines and canals; and inventory of natural resources. Even today the economic effect from the use of space information is many tens of millions of rubles. At this point there is a need to create an extensive automated industry for the transformation and interpretation of space information on the basis of high-speed optical-electronic and computer systems. The expenditures on the development of the system for studying the earth's natural resources have already paid for themselves and in the years immediately ahead the savings will exceed expenditures by not less than a factor of 12-17 and later will increase still more. Figures 1. [313-5303]

THREE-DIMENSIONAL STRUCTURE OF THE GULF STREAM FRONTAL ZONE ACCORDING TO SYNCHRONOUS SATELLITE AND SHIP DATA

Moscow ISSLEDOVANIYE ZEMLI IZ KOSMOSA in Russian No 3, 1980 pp 5-13

SKLYAROV, V. Ye. and FEDOROV, K. N., Institute of Oceanology

[Abstract] Observations from orbital stations and measurements from artificial satellites, in combination with simultaneous shipboard measurements, give data for qualitatively new concepts concerning the structure of frontal zones in the ocean. The thermal patterns of the ocean surface registered from a satellite by means of scanning IR radiometers make possible a more correct interpretation of oceanographic sections through frontal zones and detection of details of the spatial structure of these zones whose existence would not even be surmised without satellite data. Oceanologists have now been afforded the first opportunity for investigating the three-dimensional pattern of the fine structure of frontal zones in the ocean. The materials in this article are based on measurements in the Gulf Stream frontal zone in March 1978 in the region near 37°N and

73°W during the Soviet-American POLYMODE experiment. Shipboard measurements with an "Aist" hydrophysical probe (at stations) and with a towed sensor were made from the "Akademik Kurchatov." Figure 1 shows the location of the measurements. At the same time, thermal images of the ocean surface in the IR range were obtained with an IR scanning radiometer on the NOAA-5 satellite. There is a good qualitative agreement between the shipboard and satellite data in the Gulf Stream frontal zone; this is clear from the data plotted in Figure 2. Figure 3 shows the distribution of temperature with depth along the most interesting section of the Gulf Stream. Figure 4 shows that over a three-day period the position and structure of the frontal zone changed significantly. Figure 5 shows the three-dimensional fine structure of the frontal zone. Implementation of such synchronous measurements in the future can considerably accelerate the progress of investigations of frontal zones in the ocean, their structure and variability. Figures 5; tables 1; references 12: 2 Russian, 10 Western.
[353-5303]

MESOZOIC AND CENOZOIC DEPRESSIONS IN THE REGION OF THE BAYKAL-AMUR RAILROAD DETERMINED BY INTERPRETATION OF SPACE PHOTOGRAPHS

Moscow ISSLEDOVANIYE ZEMLI IZ KOSMOSA in Russian No 3, 1980 pp 27-33

VASYUTINA, L. G. and KUSKOV, A. P., "Aerogeologiya" All-Union Aerogeological Scientific-Production Combine

[Abstract] In the course of space photogeological mapping of the region of the Baykal-Amur Railroad it was found that the contours of Mesozoic and Cenozoic depressions on existing geological maps do not coincide with their outlines interpreted from space photographs. Geological, geomorphological and geophysical analyses, together with surface investigations, reveal that on space photos such depressions are outlined as integral structural elements, whereas geological maps show only sectors which are filled with deposits. Within these depressions there are frequently no deposits or the deposits are thin and scattered as a result of denudation-erosional processes or the depressions are only beginning to form and are still not filled with sediments. Despite this, the depressions show up clearly on the photoimage and frequently in physical fields as a result of the specific structure of their basement. These depressions or parts of depressions can be categorized as "uncompensated," in contrast to "compensated" depressions, whose floors are completely covered by sedimentary or volcanic-sedimentary deposits. The "uncompensated" depressions as fundamentally new structures were for the first time reflected in space

photogeological mapping of the Baykal-Amur Railroad region and on the basis of age and genesis can be classified into a number of groups, described in considerable detail in this article and mapped in Figure 1. The space photography of this region revealed a great deal of other information. For example, space photos made it possible to estimate the thickness of Mesozoic and Mesozoic-Cenozoic coal-bearing deposits, and are useful in the search for placer deposits and in discriminating basement blocks with ore mineralization or sectors with development of relicts of volcanic structures which may be accompanied by epithermal mineralization. Figures 2; references: 11 Russian.
[353-5303]

METHOD FOR COMPILING MAPS OF SOIL COVER REFLECTIVITY

Moscow ISSLEDOVANIYE ZEMLI IZ KOSMOSA in Russian No 3, 1980 pp 34-40

TISHCHENKO, A. P. and STEPANOVA, G. I., State Scientific Research Center for the Study of Natural Resources

[Abstract] Radiation from the "atmosphere-vegetation-soil" system is registered during space surveys. In order to ascertain the contribution of soils to the total radiation it is necessary to know the spatial distribution of soil reflectivities (appropriate maps must be compiled). In this article the authors evaluate the possibility of compiling maps of the reflectivity of the soil cover on the basis of soil maps, using the results of studies of the spectral coefficients of soil brightness. Figure 1 in the text gives the spectral brightness coefficients (SBC) for the soil types and subtypes most characteristic for the European USSR and the Caspian Lowland. An analysis of the curves for these soils in the spectral ranges 500-600 and 700-800 nm was made for the classification of soils on the basis of their reflective properties. In these spectral ranges, the soils could be classified in definite groups (listed in a table) depending upon the spectral brightness coefficient. For example, for the range 500-600 nm alluvial-meadow and peaty-gleyey soils constitute a group with SBC values less than 0.06. They have a reflectivity which is minimum in comparison with other soils. A second group includes all subtypes of chernozems, dark chestnut and dark gray forest soil with SBC in the range from 0.06 to 0.13. Still another group with SBC in the range from 0.13 to 0.19 includes desert-sandy, light chestnut, light gray forest soils and line solonets, as well as others, with SBC in the range 0.19 to 0.25. Brown desert-steppe soils (SBC 0.30) have the highest reflectivity. In the spectral range 700-800 nm there is a somewhat different pattern of distribution of soils by groups depending upon the SBC values. The structure of the map legend is described. The most important map content is the soil types and their reflectivities in the spectral ranges 500-600 and 700-800 nm. Figures 2 and 3 in the text are examples of such maps at

a scale of 1:2,500,000 for the central and southern parts of the European USSR and the Caspian Lowland. Preparation of such maps is relatively simple. A space photo from the "Meteor" artificial earth satellite, reproduced on page 40, illustrates the pattern of reflectivity of the soil cover under natural conditions. In general, the photo and maps coincide. This fact is indirect evidence of a significant contribution of reflection from soils to radiation of the "atmosphere-vegetation-soil cover" system. Figures 4; tables 1; references: 4 Russian.
[353-5303]

OPTICAL METHODS FOR STUDYING PLANT COENOSES ON THE LAND AND AT SEA

Moscow ISSLEDOVANIYE ZEMLI IZ KOSMOSA in Russian No 3, 1980 pp 41-50

SID'KO, F. Ya., APONASENKO, A. D., FILIMONOV, V. S., FRANK, N. A., SID'KO, A. F., SHUR, L. A. and SOKOLOV, V. I., Physics Institute imeni L. V. Kirenskiy, Siberian Department USSR Academy of Sciences

[Abstract] This review is devoted to investigations of the optical properties of plant associations, studies of the possibilities of using the spectrometric method for determining the content and distribution of coenoses of different types of plants, evaluating their physiological state and biological productivity on the basis of investigating the optical properties of plant associations. Information is given on the complex of optical instruments and their use in studies of the spectral brightness of internal water bodies and seas, fields of agricultural crops, forests and other types of vegetation. The absorption and attenuation indices and other optical characteristics of water have been determined. The possibility of determining the content of phytoplankton in water by remote and contact optical methods has been demonstrated. Information is given on the relationship between the spectral brightness coefficients of agricultural fields and forests and their species composition and state. The results of these and other investigations show that already at the present time it is possible to create and develop systems of remote optical methods and instruments for the continuous monitoring of the state of the environment, for studying and evaluating the anthropogenic effect on plant associations and ecosystems of the land and sea and collecting data necessary for the compilation of maps reflecting the physiological state and optical properties of plant coenoses in different climatic zones and in solving many environmental protection problems. Figures 7: references 21: 19 Russian, 2 Western.
[353-5303]

ALLOWANCE FOR LIGHT SCATTERING IN THE ATMOSPHERE IN PROCESSING SPACE PHOTOGRAPHS OF THE EARTH'S SURFACE

Moscow ISSLEDOVANIYE ZEMLI IZ KOSMOSA in Russian No 3, 1980 pp 58-68

ZOLOTUKHIN, V. G., USIKOV, D. A. and GRUSHIN, V. A., Space Research Institute, USSR Academy of Sciences

[Abstract] As a result of light scattering by the atmosphere the images of the earth's surface obtained from space differ from the images of these same sectors obtained directly over the surface even with complete coincidence of all other experimental conditions. There are three effects associated with light scattering by the atmosphere which for the most part determine the distortions introduced by the atmosphere: 1) deterioration of photographic resolution, 2) disturbance of light transmission, 3) disturbance of color transmission. The objective of this article is to define ways for making allowance for these and other effects arising due to atmospheric light scattering, reduction of space photography to surface photography and determination of albedo of the earth's surface. The following are considered in detail: a) atmospheric radiation transfer equation, b) methods for solving the "space" photography equation, c) methods for computing transmission functions, d) standard atmosphere transmission functions. On this basis the authors solve the problem of allowance for atmospheric light scattering by solving the one-dimensional transfer equation and subsequently using a two-dimensional Fourier transform. All this makes it possible to improve the quality of space photographs, but the method outlined here is also applicable for such cases as photography under water and through water, in reontgenography, and in all other cases when it is necessary to account for radiation scattering. Figures 7; tables 2; references 9: 7 Russian, 2 Western.
[353-5303]

ATTENUATION OF WATER SURFACE RADIATION CONTRASTS IN THE ATMOSPHERE IN THE SPECTRAL REGION 10-12 μm

Moscow ISSLEDOVANIYE ZEMLI IZ KOSMOSA in Russian No 3, 1980 pp 69-75

GORODETSKIY, A. K., Institute of Oceanology

[Abstract] Measurements of the intensity of outgoing radiation made using satellite radiometers in the spectral range 10-12 μm can be used in determining the absolute temperature of the ocean surface and in determining the field of radiation temperature gradients. Currents, eddies and frontal zones can be determined from thermal contrasts. However, the atmosphere must be taken into account in ascertaining contrasts of the temperature field of water surface areas. In this spectral region the blurring of temperature contrasts is caused mostly by the variable

atmospheric components: water vapor and aerosol. In this paper the author evaluates the influence of water vapor, and in part aerosol, on the distortion of contrasts of water surface radiation. The following aspects of the problem are considered in detail: use of transfer function, dependence of transmission function on humidity, computations of the contrast transfer coefficient, errors in determining temperature contrasts. It is shown here that use of the transfer function $\bar{P}$ makes it possible to determine only the spatially averaged surface radiation, whereas variations of radiation relative to the mean level must be ascertained using the contrast transfer coefficient γ, computed for a given region either on the basis of complex measurements or statistical or mean climatic data. Figures 4; tables 2; references 14: 10 Russian, 4 Western.
[353-5303]

EFFECT OF CLOUD COVER ON AVERAGED RADIOTHERMAL RADIATION OF THE "ATMOSPHERE-OCEAN SURFACE" SYSTEM

Moscow ISSLEDOVANIYE ZEMLI IZ KOSMOSA in Russian No 3, 1980 pp 76-83

KUTUZA, B. G. and SMIRNOV, M. T., Institute of Radio Engineering and Electronics, USSR Academy of Sciences

[Abstract] The authors give computed estimates showing a weak influence of the vertical profiles of temperature and liquid-water content and the droplet-size distribution within clouds on the SHF spectrum of their absorption. The influence of the spatial distribution of the liquid-water content of clouds on the averaged radiation of the "atmosphere-ocean surface" system is investigated in the case of observation from a satellite with a spatial resolution not better than 15 km. The article gives the results of model computations with the use of two cloud-size distribution functions. A method is proposed for the processing of experimental data obtained by means of SHF radiometric measurements at wavelengths of 0.8 and 1.35 cm, taking into account the spatial structure of cumulus clouds. The results of computations indicate that the errors in determining the water content and total mass of water vapor caused by failure to take cloud cover nonuniformity into account can attain 30-40% and 0.5 g/cm^2 respectively. It is clear that when processing the results of satellite SHF radiometric measurements it is necessary to taken into account the nature of the distributions of cloud fields obtained when using data from optical and infrared measurements. Figures 7; tables 2; references 15: 12 Russian, 3 Western.
[353-5303]

SOME EVALUATIONS OF ACCURACY OF ENERGY TIE-IN OF MATERIALS FROM MULTIZONAL PHOTOGRAPHY

Moscow ISSLEDOVANIYE ZEMLI IZ KOSMOSA in Russian No 3, 1980 pp 104-107

ISTOMINA, L. G., Institute of Oceanology

[Abstract] The high quality of the photographs obtained with the MKF-6 camera, taken simultaneously in six narrow spectral zones, the good resolution and sensitometric tie-in of frames, afford possibilities for using these materials in a quantitative description of the structure of reflected radiation in a broad range of the visible and near-IR spectrum. The first step in solving this problem is an objective analysis of the accuracy and reliability of determining absolute spectral brightness values from photographs of terrestrial features. The most convenient object of investigation for such purposes is water surfaces, whose spatial uniformity makes it possible to obtain sufficiently reliable mean characteristics of the spectral brightness of the "water surface-atmosphere" system. The feature investigated by the author was Lake Baykal. The photometric procedures used are briefly described. The results are compared with data from aircraft measurements of the absolute intensity of solar radiation reflected from the ocean. Despite certain discrepancies in the results (closer attention must be given to light filter and film effects), it is concluded that materials from space photography with the MKF-6 camera make it possible to obtain reliable quantitative characteristics of the spatial and spectral structure of the radiation reflected by terrestrial features. Figures 4; references 2: 1 Russian, 1 Western. [353-5303]

CALCULATION OF SCATTERING COEFFICIENT IN RADIO SENSING OF ICE

Moscow ISSLEDOVANIYE ZEMLI IZ KOSMOSA in Russian No 3, 1980 pp 108-110

NIKITIN, P. A., State Scientific-Research Center for Study of Natural Resources

[Abstract] A quite simple method is proposed for calculating the volume scattering coefficient on the basis of the known density of ice, using the dependence of the relative dielectric constant of ice on its physicochemical characteristics, as well as with attention to the effects of scattering on structural inhomogeneities in ice. It is taken into account that studies have strongly indicated a nonlinear dependence of the attenuation of SHF radiation on ice density. It is important to consider that as a result of summer thermal metamorphism the upper ice layers are freshened and saturated with air. The brief computations given here show that the scattering coefficient should increase with a decrease in density, but the attenuation coefficient γ, determined for SHF radiation in

freshened ice, is nonlinearly dependent on density. This effect is evidently attributable to the fact that in the case of small densities there is a large number of scatterers per unit volume and the distance between them becomes equal to or less than the wavelength. The coherence of the scattered radiation increases. In the first approximation the mutual influence of the scatterers can be taken into account by introducing the effective dielectric constant. A modified formula makes it possible to compute the scattering coefficient for a low ice density. Accordingly, the formulas presented here are effective in computing the electric characteristics of ice, including the scattering parameters of fresh ice of inhomogeneous structure. Figures 1; references: 4 Russian.
[353-5303]

PROBLEMS IN EVALUATING INFORMATION PROPERTIES OF SPACE PHOTOGRAPHIC SURVEY MATERIALS AND EQUIPMENT

Moscow ISSLEDOVANIYE ZEMLI IZ KOSMOSA in Russian No 2, 1980 pp 84-91

MATIYASEVICH, L. M., "Priroda" State Scientific Research and Production Center

[Abstract] A study was made of the possibility of applying information theory for evaluating the properties of space photographic systems. The author formulates the problems involved in evaluating the information properties of these systems, makes a choice of evaluation criteria and describes methods for determining their numerical values. It is shown that at the present time the possibilities of using the quantitative characteristics of the classical theory of information (entropy, quantity of information, and others) for evaluation of space photographic surveys are extremely limited. Nevertheless, as indicated in this paper, many ideas in the theory of information and its individual concepts are of great importance in the development of space photographic methods for investigating the earth's natural resources. Considerable attention is given to determination of the numerical values of the information criteria L and $\hat{P}$ (resolution in the terrain and statistical probability (frequency) of matching the events of detection and recognition of objects of a stipulated class (type) on the basis of photosurvey materials; this is followed by an analysis of the relationship between $\hat{P}$ and L. In the method proposed here no use is made of universal units of the quantity of information. Nevertheless, use of the method affords broad possibilities for optimizing space survey processes and equipment. The method can be employed for evaluating not only photographic, but also other video equipment (television, thermal, radar). Figures 3; references 16: 14 Russian, 2 Western.
[313-5303]

"METEOR" SPACE SYSTEM IN THE SERVICE OF HYDROMETEOROLOGY

Moscow ISSLEDOVANIYE ZEMLI IZ KOSMOSA in Russian No 2, 1980 pp 11-27

VETLOV, I. P., State Scientific Research Center for the Study of Natural Resources

[Abstract] The "Meteor" space system for collecting data on the environment in the interests of hydrometeorology consists of both operational and experimental satellites. Operational satellites are outfitted with a package of standard instruments and are put into quasipolar orbits with an altitude of 900 km and an inclination of 81° to the equatorial plane, whereas the instrumentation aboard the experimental satellites varies and they are launched into quasipolar solar-synchronous orbits at an altitude of 600 km. Improved second-generation satellites ("Meteor-2") are now used for the collection of routine information. The system has made a major contribution to the improvement of analysis and prediction of weather-forming processes over the oceans and remote land regions. Considerable successes have been attained in the field of interpretation of satellite photographs in the visible and IR spectral ranges. In addition to weather analysis and prediction, satellite photographs have found use in hydrology, oceanology, climatology and other fields of hydrometeorology. They have been an important source of information for servicing aviation, navigation and fishing, agriculture, forestry, water management and other branches of the national economy. The ways in which this operational information are used are discussed. A table lists the experimental instrumentation carried aboard "Meteor" satellites. Some experimental investigations are discussed, such as thermal sounding of the atmosphere with spectrometric IR instruments operating in the range 10-17 μm, including the CO_2 absorption band. The possibilities of increasing the accuracy of remote sensing of the atmosphere with a spectrometer-interferometer developed in the GDR are discussed. Experiments have included an analysis of the possibilities of a multizonal survey in the visible and IR spectral ranges using scanning apparatus of the TV type. Hydrometeorological information on processes and phenomena at the surface of the land and ocean obtained from multizonal photographs is characterized by greater completeness, detail and accuracy than the information which is extracted from an analysis of ordinary photographs in the visible spectral range from operational "Meteor" satellites. Qualitatively new hydrological information has been obtained, and many agrometeorological problems have become soluble as a result of the introduction of multizonal photography. Weather forecasting, study of climate and the oceans, environmental monitoring--all have profited enormously from the application of space methods. Figures 8; tables 1; references 22: 17 Russian, 5 Western.
[313-5303]

MODERN ASPECTS OF DEVELOPING REMOTE METHODS OF GEOLOGICAL RESEARCH

Moscow ISSLEDOVANIYE ZEMLI IZ KOSMOSA in Russian No 2, 1980 pp 28-33

KOMAROV, V. B., "Aerogeologiya" All-Union Scientific-Production Combine; Aerial Methods Laboratory

[Abstract] This article deals with both aerial and aerospace methods for geological research, with emphasis on aerial methods. The different types of surveys and instrumentation are reviewed. For example, in a thermal survey invisible IR radiation is transformed into electric signals which are registered in the form of a curve or image. Such materials are of great interest for environmental studies. Since an enormous number of natural features and phenomena are accompanied by temperature contrasts, the possibility of rapid determination of these contrasts over great areas makes it possible to obtain valuable geological information inaccessible or hard to collect by other methods. In volcanology an IR aerial survey makes it possible to obtain thermal maps of volcanoes which have considerably augmented the data available on their geological structure and which make it possible to predict possible periods of their activization. A special method makes it possible to study the temperature structure of the geothermal fields of craters. Repeated surveys have been made of a number of active volcanoes on Kamchatka: Avacha, Mutnovskiy, Karymskiy, Gorelyy, Kikhpinych, Ebeko, and others. Similarly, the review presents details concerning photographic and radar surveys, the highly important multispectral survey method, and such relatively new types of surveys as radiothermal, aerogeochemical, and super-high frequency deep sounding. The need for computer processing of remote sensing data is emphasized and the most successful application of remote sensing techniques can be achieved by studying the relationship between geological and landscape features in different parts of the electromagnetic spectrum.
[313-5303]

USE OF SPACE PHOTOGEOLOGICAL MAPS IN PREDICTING ORE REGIONS

Moscow ISSLEDOVANIYE ZEMLI IZ KOSMOSA in Russian No 2, 1980 pp 34-43

BELOBORODOV, M. A. and KOGEN, V. S., "Aerogeologiya" All-Union Aerogeological Scientific-Production Combine

[Abstract] The article discusses the possibilities of predicting ore regions on the basis of the joint use of space photogeological maps and geological-geophysical data. The method of predictive-mineragenetic investigations on the basis of space photogeological maps has been developed through the example of evaluating the prospects for finding ores in a Far Eastern region with an area of about 160,000 km^2. The object of investigation was an ore region whose area according to empirical data was between

300 and 400 km^2. The problem was solved by applying the previously-developed "Otsenka" (evaluation) algorithm which involves use of the analogy method, which in essence is the sole geological prediction method. The problem essentially involves an evaluation of the "similarity measure" for the investigated area and an area studied earlier in which ore deposits were found. The basis for the "Otsenka" algorithm, like other prediction algorithms based on image recognition methods, is the derivation of some function whose arguments are the values of the indicators at points in the investigated area. This function must assume the most different values with substitution of arguments corresponding to objects of different classes. The values assumed by such a function are the criterion for the classification of objects. A program was devised which makes it possible to formulate an optimum model of an ore region and obtain a predictive index for the area. Forty-nine indicators were used in the case described; these are all given in a table. Sixteen of these indicators were geological; 17 were space photogeological; 16 were geophysical. Two fundamental conditions for the choice of indicators were: a) they must be described for the entire investigated territory, b) the initial set of indicators includes their maximum number; those which seem to be insignificant are included because part of the task is an evaluation of their significance and those of little importance will be excluded automatically in the course of solution of the problem. The use of space photogeological maps made it possible to reduce the area of the promising sectors by two-thirds. The information significance of space photogeological indicators is commensurable with the significance of information given on geological maps of the same scale. In most cases space photogeological information does not duplicate already known geological information and contains fundamentally new information. The example cited in the article shows the effectiveness of space photogeological maps in predictive-minerageneric investigations. Figures 2; tables 3; references: 3 Russian.
[113-5303]

PROBLEMS IN AEROSPACE SPECTROMETRY OF THE EARTH'S SURFACE

Moscow ISSLEDOVANIYE ZEMLI IZ KOSMOSA in Russian No 2, 1980 pp 66-75

AVANESOV, G. A., Space Research Institute

[Abstract] Further progress in the field of automation of the processes in interpretive processing requires the exclusion of man from any role, thus involving a partial or complete transfer of his intellectual functions to an electronic computer. One of the bases of man's intellectual functions is his a priori knowledge of the investigated object. The transfer of this knowledge to an electronic computer involves the creation of a data bank establishing a connection between the mass of remotely measured physical values and the form, state and quantitative characteristics of

the studied sector of the earth's surface. The problem of creating a bank of a priori data can be regarded as a statistical generalization of temporal physical descriptions and on this basis construction of a unified system suitable for use in modern computer complexes. Applicable to the study of the earth from space, an investigation of the possibilities and development of methods for the dynamic description of the types and states of objects on the earth's surface through remotely measured physical characteristics is the basic problem in modern aerospace spectrometry. Solution of this problem requires simultaneous collection of information on texture of the surface, its spectral-energy characteristics and data on the contribution of the atmosphere in the collected information. The author discusses the three principal aspects of the problem: physical, methodological and technical. The instruments used in solving these problems should have approximately 24 channels in the visible and near-IR ranges. A successful solution of the problems involved in obtaining spectrometric and videoinformation for the range 0.4-1.1 μm is possible by use of a so-called "panoramic videospectrometer," a diagram of which accompanies the text. An IR-scanning instrument for obtaining the spectral-energy characteristics in the range 1.1-15 μm with about 8 channels can, in principle, be constructed similar to the instrument for the range 0.4-1.1 μm. Figures 2; tables 1; references 12: 4 Russian, 8 Western.
[313-5303]

ORBITAL PARAMETERS AND SENSORS OF A SYSTEM FOR STUDYING THE EARTH'S NATURAL RESOURCES

Moscow ISSLEDOVANIYE ZEMLI IZ KOSMOSA in Russian No 2, 1980 pp 57-65

RAMM, N. S., KUZINA, A. M. and MAL'TSEVA, I. G., Aerial Methods Laboratory, "Aerogeologiya" All-Union Scientific-Production Combine

[Abstract] Satellites for studying the earth's natural resources are those intended for a repeated, rigorously periodic survey of the earth's entire surface over a period of one or more years with the routine transmission of data to ground reception stations. The "Meteor" system falls in this category. It has been established that the orbits of such satellites should be nearly circular with an eccentricity $e \leq 0.003$, should be solar-synchronous, have an altitude from 400-500 to 1,000 km and their trajectories should cover the earth's surface along equally distant paths, in each of the periods passing over one and the same terrain points. Orbits satisfying these conditions could be called isotrajectory orbits. This paper gives a detailed examination of such orbits, describing the totality of parameters directly related to survey conditions and giving the derivation of dependences necessary for ballistic computations, comparison and selection of variants of such systems. A table gives orbital and survey

parameters promising for such systems for the study of the earth's natural resources. The interdependence between the parameters of an isotrajectory orbit, the parameters of the sensors and the survey characteristics is examined. Figures 3; tables 1; references: 8 Russian.
[313-5303]

SUBOPTIMUM DECISION RULE WITH DYNAMIC CRITERION OF CHOICE OF INDICATORS

Moscow ISSLEDOVANIYE ZEMLI IZ KOSMOSA in Russian No 2, 1980 pp 76-83

ASMUS, V. V., GRIGOR'YEVA, O. N. and TISHCHENKO, A. P., State Scientific Research Center for the Study of Natural Resources

[Abstract] The authors examine the formulation of an almost optimum decision rule which does not require special assumptions concerning the nature of the initial data and obtain analytical results for evaluating its parameters. For an algorithmic realization of the almost optimum decision rule the authors also propose a new approach to the problem of the choice of criterial space, which can be called the dynamic approach. In contrast to the traditional approach, in the dynamic approach criterial space is not selected prior to the beginning of classification, but directly in the recognition process and for each pair of classes. A highly important characteristic of the dynamic approach is that the effectiveness of its use increases with an increase in the number of classes and the dimensionality of the observation vector. The computational effectiveness of the dynamic approach is attributable to the fact that in the calculation process use is made of as many criteria as are necessary for adoption of a decision. There is a correlation between the positioning of measurements according to the dynamic criterion and the well-known measures in the theory of information. Since the almost optimum decision rule and the Bayes decision rule essentially involve computation of virtually the same expressions, the dynamic criterion can be realized within the framework of the traditional Bayes approach, which substantially (by an order of magnitude or more) increases its speed without exerting an influence on the classification results. A test analysis of the almost optimum rule indicates the desirability of its use (instead of the traditional Bayes approach) for real data not having normal distributions, in particular for the recognition of multizonal space videoinformation from artificial earth satellites of the "Meteor" series. References: 5 Russian.
[313-5303]

UDC 550.814:528.711.1(202/203)

GEOLOGICAL INVESTIGATIONS FROM AIR- AND SPACE-BORNE PLATFORMS IN THE GEOLOGICAL SURVEYING PROCESS

Moscow SOVETSKAYA GEOLOGIYA in Russian No 4, Apr 80 pp 29-40

MOZHAYEV, B. N., LAEM, "Aerogeologiya" All-Union Scientific Production Combine

[Abstract] The author attempts to define the place of investigations from air- and space-borne platforms in the geological surveying process and their effect on increasing the efficiency of geological surveying work as a whole. He categorizes the applicability and utility of aerovisual observations and such methods as infrared and radar aerial surveying, among others, for such areas of interest in geological surveying as investigating stratified formation, studying Quaternary deposits and magmatic rocks and so on. In conclusion, the author states that the USSR lags behind the United States in the use of these methods in geological surveying and says that they must become an integral part of such work. References 11. [316-11746]

UDC 528.225:629.783

REAL-TIME DETERMINATION OF POSITION OF EARTH'S CENTER OF MASS AND OF REFERENCE POINTS OF THE GEODETIC COORDINATE SYSTEM BASED ON SATELLITE OBSERVATIONS

Moscow IZVESTIYA VUZ, GEODEZIYA I AEROFOTO"YEMKA in Russian No 2, 1980 pp 48-53 manuscript received 2 Feb 79

MASHIMOV, M. M., professor, doctor of engineering sciences, MALETS, K. V., candidate of engineering sciences, and SHVETS, A. I., junior scientific coworker; Order of Lenin Red Banner Military-Engineering Academy imeni V. V. Kuybyshev

[Abstract] The feasibility of determining the position of the earth's center of mass and of reference points of the geocentric coordinate system based on satellite observations over a period of a few days is examined in the article, which is a continuation of previous studies conducted by the authors. The coupling equations of the geocentric coordinates and differential relations for the topocentric distance, hour angle and declination of the satellite are given. The precision of real-time determination of the center of mass and reference points is determined as functions of the time of accumulation and composition of measurement information, the number of astrogeodetic observatories in the network, precision characteristics of the measurement information and errors of the raw data. A large volume of numerical data is obtained as a result

of repeated computer processing by the least squares procedure. An analysis of the data shows that the center of mass and reference points can be located with great precision on the basis of the results of ranging observations of satellites relative to the geocentric coordinate system with an error of a few centimeters over a period of 2-4 days. An increase of the number of astrogeodetic observatories in the middle of the geodetic network does not significantly improve precision. The combined use of goniometric and ranging information is most effective when low orbital synchronous satellites are used. Figures 5; references: 1 Russian.
[347-7872]

UDC 528.711.1 778.6

ELECTROOPTICAL MEASUREMENT OF COLOR CHARACTERISTICS OF COLOR PHOTOGRAPHY

Moscow IZVESTIYA VUZ, GEODEZIYA I AEROFOTOS"YEMKA in Russian No 2, 1980 pp 65-70 manuscript received 18 Dec 78

ZHURKIN, I. G., reader, candidate of engineering sciences, and SHAVEN'KO, N. K., candidate of engineering sciences; Moscow Order of Lenin Institute of Geodetic, Aerial Photographic and Cartographic Engineers

[Abstract] A model of the passage of light through film in the form of a transparent medium with particles of pigment imbedded in it is examined for electrooptical measurement of color characteristics with a view toward automatic processing of color information. The spectral characteristics of pigment are assumed to determine the color tone of an individual film, and the concentration of the pigment determines the purity of the color, expressed as the ratio of the total area of the pigment particles to the total area of an analyzed portion. Light passes through the film as two beams, one through the pigment and the other unimpeded. The parameters of the color image are determined automatically by scanning the image with white light and analyzing the output signals of two photoreceivers using analytical relations that make it possible to measure the color characteristics of an image on the basis of the output signals, so that satellite photographs of the earth's surface and environment can be analyzed automatically with simple instruments. Figures 2; references: 4 Russian.
[347-7872]

SPACE POLICY AND ADMINISTRATION

DEATH OF 'INTERCOSMOS' CHAIRMAN ANNOUNCED

Moscow World Service in English 1400 GMT 26 Aug 80

[Text] The chairman of the "Intercosmos" Council Professor Boris Petrov has died in Moscow. The obituary, signed by President Brezhnev and other Soviet leaders, notes his major contribution to the development of science in this country. For the last few year Professor Petrov devoted his efforts to fundamental space exploration. He pioneered international cooperation in this field, as a member of several foreign academies and a member of the International Astronautics Academy.
[1866-P]

CSO: 1866

PROSPECTS FOR METEOROLOGICAL OBSERVATIONS FROM ORBITAL SPACE STATIONS IN THE UNITED STATES

Moscow ISSLEDOVANIYE ZEMLI IZ KOSMOSA in Russian No 3, 1980 pp 111-119

KONDRAT'YEV, K. Ya.

[Abstract] This review of the prospects for meteorological observations from orbital space vehicles, both "Spacelab" and the space shuttle, is quite detailed but strictly factual, the information being drawn exclusively from published English sources. The author makes no attempt at evaluating the relative effectiveness of present or future work in this research field in the United States and the Soviet Union. The material presented here is a description of instrumentation and theoretical investigations directed to solution of a variety of inverse problems in remote sensing of the atmosphere, land and ocean. Particular attention is given to work related to the use of microwave radiometers and radars for remote sensing. The comparative capabilities of multichannel scanning radiometers in the optical range of wavelengths and active radar are compared. Investigations of solar-terrestrial relationships are briefly discussed, much more emphasis being placed on the use of space techniques in relation to studies of the Earth's environment and resources. Tables 3; references 17: 9 Russian, 8 Western.
[353-5303]

CSO: 1866

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October 17, 1980

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